

Application No. 09/856,431

IN THE SPECIFICATION

Please amend the specification as follows:

Page 20, last paragraph:

Recently, in accordance with development in electronic technology, a number of portable electron devices such as VTRs (video tape recorder) with a built-in camera, cellular phones and laptop computers have come into wide use, and miniaturization and ~~volume~~ weight-reduction of the devices have become the subject. Research and developing aimed at improving energy density of batteries used for portable power sources for the devices, specially secondary batteries, have been actively conducted.

Page 22, first paragraph

the low-volatile solvent is preferably containing from 10 percent by ~~volume~~ weight to 80 percent by ~~volume~~ weight, both inclusive, of the polyolefin composite, more preferably containing from 15 percent by ~~volume~~ weight to 70 percent by ~~volume~~ weight, both inclusive, of the polyolefin composite provided the sum of both is 100 percent by ~~volume~~ weight. The reason is that if the ~~volume~~ weight of polyolefin composite is too small, imbibition occurs in the exit of the die or the neck-in becomes large at the time of molding so that molding of a sheet becomes difficult. On the other hand, if the volume of polyolefin is too large, preparation of the homogeneous solvent is difficult.

Page 24, first paragraph

by being mixed. Washing is performed by a method of soaking the stretched film in a volatile solvent, a method of sprinkling the volatile solvent over the film, or a

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combined method of these. Washing is performed until less than 1 percent by ~~volume~~ weight of the low-volatile solvent remains in the stretched film to 100 percent by ~~volume~~ weight of polyolefin composite.

Page 24, paragraph three

However, when graphite is used for the negative electrode 15, the concentration of propylene carbonate in the non-aqueous solvent is preferable to be less than 30 percent by ~~volume~~ weight. Propylene carbonate exhibits relatively high reaction to graphite so that the characteristic is deteriorated if the concentration of propylene carbonate is too high. When the non-aqueous solvent contains ethylene carbonate and propylene carbonate, preferably the mass fraction (ethylene carbonate \square propylene carbonate) of mixing ethylene carbonate with propylene carbonate in the non-aqueous solvent, which is the value obtained by dividing the content of ethylene carbonate by the content of propylene carbonate, is 0.5 and more.

Page 25, paragraph two

It is preferable that the concentration of 2,4-difluoroanisole in the non-aqueous solvent is, for example, 15 percent by ~~volume~~ weight and below. The reason is that the discharging capacity cannot be improved if the concentration is too high. It is preferable that the concentration of vinylene carbonate in the non-aqueous solvent is, for example, 15 percent by ~~volume~~ weight and below. The reason is that the cycle characteristic cannot be improved if the concentration is too high.

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Page 29, first paragraph

Furthermore, if the ability of discharging capacity of the negative electrode material is 150 mAh/g and more and the negative electrode material contains 50 percent by ~~volume~~ weight and more of a negative electrode active material, the cycle characteristic and the boosting charging characteristic can be further improved.

Page 30, first paragraph

In addition, if the concentration of propylene carbonate in the non-aqueous solvent is less than 30 percent by ~~volume~~ weight and the mass fraction of mixing ethylene carbonate with propylene carbonate is 0.5 and more, the cycle characteristic can be improved even if graphite is used as the negative electrode material.

Page 33, third paragraph

First, lithium-cobalt composite oxide (LiCoO_2) as the positive electrode material was obtained by mixing lithium carbonate (Li_2CO_3) and cobalt carbonate (CoCO_3) in the proportion of $\text{Li}_2\text{CO}_3 : \text{CoCO}_3 = 0.5 : 1$ (molar fraction) and calcining it in the air at 900 °C for five hours. When the lithium-cobalt composite oxide obtained was measured by performing X-ray diffraction, the peak was very similar to that of LiCoO_2 registered in JCPDS file. After pulverizing the lithium-cobalt composite oxide to be in a form of powder with the accumulated 50 % particle diameter being 15 μm , which could be obtained by a laser diffraction, 91 parts by ~~volume~~ weight of the lithium-cobalt composite oxide powder, 6 parts by ~~volume~~ weight of graphite as a conductive agent, and 3 parts by ~~volume~~ weight of polyvinylidene fluoride as a binder were mixed in order

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to prepare the positive electrode mixture. Then, the positive electrode mixture was dispersed in N-methyl-2-pyrrolidone comprising a solvent to obtain slurry which was then homogeneously applied on one face of a positive electrode collector layer 13b made of 20 μ m thick aluminum foil. It was then dried and compression-molded by a roll-presser in order to form a positive electrode mixture layer 13a. Then, it was stamped out to fabricate a circular-plate positive electrode 13.

Page 45, second paragraph

As Example 1-22, a secondary battery was fabricated in the same manner as in Example 1-1 except that the positive electrode mixture was prepared by mixing 90 parts by ~~volume~~ weight of lithium-cobalt composite oxide (LiCoO_2), 6 parts by ~~volume~~ weight of graphite, 3 parts by ~~volume~~ weight of polyvinylidene fluoride, and 1 part by ~~volume~~ weight of lithium carbonate (Li_2CO_3). In the secondary battery, the general charging/discharging test and the boosting charging/discharging test were also performed in the same manner as in Example 1-1, respectively. The results are shown in Table 5, respectively, along with the results of Example 1-1.

Page 48, first paragraph

As Example 1-29, a secondary battery using a gel electrolyte instead of the electrolyte 17 was fabricated. First, the positive electrode 13 and the negative electrode 15 were formed, respectively, in the same manner as in Example 1-1. Then, a gel electrolyte was formed on each surface of the negative electrode mixture layer 15a and the positive electrode mixture layer 13a. The gel electrolyte was obtained in the

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following manner. First, an electrolyte was prepared by dissolving 1 mol/dm³ of LiPF₆ in a non-aqueous solvent in which 50 percent by volume of propylene carbonate and 50 percent by volume of dimethyl carbonate were mixed. Then, a mixed solvent obtained by mixing 30 parts by ~~volume~~ weight of the obtained electrolyte, 10 parts by ~~volume~~ weight of block co-polymer of polyvinylidene fluoride and polyhexafluoropropylene, which was a polymer compound, and 60 parts by ~~volume~~ weight of dimethyl carbonate was homogeneously applied on the surface of the positive electrode mixture layer 15a and the positive electrode mixture layer 13a, and then dimethyl carbonate was evaporated and removed by leaving it for 8 hours at room temperature. Then, the negative electrode 13 and the positive electrode 15 were compressed and fixed with the sides to which the gel electrolyte was applied facing each other, and was enclosed inside the battery can 11. Thereby, a secondary battery was fabricated in the same manner as in Example 1-1.

Page 50, second paragraph

First, lithium-cobalt composite oxide powder obtained in the same manner as in Example 1-1 was prepared. Then, a positive electrode mixture was prepared by mixing 94 parts by ~~volume~~ weight of the mixture in which 5 parts by ~~volume~~ weight of lithium carbonate powder was mixed with 95 parts by ~~volume~~ weight of the lithium-cobalt composite oxide powder, 3 parts by ~~volume~~ weight of ketjen black as a conductive agent, and 3 parts by ~~volume~~ weight of polyvinylidene fluoride as a binder. The positive electrode mixture was dispersed in a solvent such as N-methyl-2-pyrrolidone, thereby obtaining a positive electrode mixture slurry. The positive electrode mixture slurry was

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applied on both sides of the positive electrode collector layer made of aluminum foil band 20 μ m thick and then the solvent was dried. Then, a positive electrode mixture layer was formed by performing compression-mold thereon. Thereby, a positive electrode 31 was fabricated. At this time, the total thickness of the positive electrode 31, which is the sum of the thickness of the positive electrode collector layer and the positive electrode mixture layer, was formed to be 150 μ m. Then, a positive electrode lead 35 made of aluminum was fixed to one end of the positive electrode collector layer.

Page 50, third paragraph

Artificial graphite with the ability of 320 mAh/g charging capacity was prepared as the negative electrode material. Then, a negative electrode mixture was prepared by mixing 90 parts by ~~volume~~ weight of the artificial graphite and 10 parts by ~~volume~~ weight of polyvinylidene fluoride as a binder. The negative electrode mixture was dispersed in a solvent such as N-methyl-pyrrolidone, thereby obtaining a negative electrode mixture slurry. The negative electrode mixture slurry was applied on both sides of the negative electrode collector layer made of copper foil band 15 μ m thick and then the solvent is dried. Then, a negative electrode mixture layer was formed by performing compression-mold thereon. Thereby, a negative electrode 32 was fabricated. At this time, in Example 2-1 to Example 2-4, the balance of the positive electrode 31 and the negative electrode 32 was changed, respectively by changing the total thickness of the negative electrode collector layer and the negative electrode mixture layer as shown in Table 9. Then a positive electrode lead 36 made of nickel was fixed to one end of the negative electrode collector layer.

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Page 57, second paragraph

As can be seen from Table 10, an excellent discharging capacity and discharging capacity retention rate were obtained in each of Example 2-5 to Example 2-11. The discharging capacity retention rate became higher when the concentration of propylene carbonate was made higher, and the discharging capacity retention rate was the maximum in Example 2-6 where the concentration of propylene carbonate was about 12.5 percent by ~~volume~~ weight. The characteristic became deteriorated in Example 2-11 where the concentration of propylene carbonate was 30.0 percent by ~~volume~~ weight. The reason is that propylene carbonate reacts with the graphite since the graphite is used for the negative electrode 32. The mass fraction of mixing ethylene carbonate with propylene carbonate was 0.53 in Example 2-11.

Page 57, third paragraph

In other words, precipitating/dissolving of lithium metal can be effectively reacted if the electrolyte contains ethylene carbonate, dimethyl carbonate, ethyl-methyl carbonate, and propylene carbonate. Thereby, an excellent characteristic can be obtained. Also, it is verified that the cycle characteristic can be improved if the concentration of propylene carbonate in the non-aqueous solvent is 30 percent by ~~volume~~ weight, exclusive, and the mass fraction of mixing ethylene carbonate with propylene carbonate in the non-aqueous solvent is 0.5 and below when using graphite for the negative electrode 32.

Page 58, second paragraph

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As can be seen from Table 11, the discharging capacity was the maximum in Example 2-14 where the concentration of 2,4-difluoroanisole was 1.2 percent by ~~volume~~ weight. The characteristic deteriorated in Example 2-16 where the concentration of 2,4-difluoroanisole was 15.8 percent by ~~volume~~ weight. In short, it is verified that the discharging capacity can be improved if 2,4-difluoroanisole is contained in the electrolyte. Furthermore, if the concentration of 2,4-difluoroanisole is 15 percent by ~~volume~~ weight and below, a larger discharging capacity can be obtained. [Example 2-17 to Example 2-21]

Page 59, second paragraph

As can be seen from Table 11, the discharging capacity was the maximum in Example 2-14 where the concentration of 2,4-difluoroanisole was 1.2 percent by ~~volume~~ weight. The characteristic deteriorated in Example 2-16 where the concentration of 2,4-difluoroanisole was 15.8 percent by ~~volume~~ weight. In short, it is verified that the discharging capacity can be improved if 2,4-difluoroanisole is contained in the electrolyte. Furthermore, if the concentration of 2,4-difluoroanisole is 15 percent by ~~volume~~ weight and below, a larger discharging capacity can be obtained.

Page 60, first paragraph

As can be seen from Table 13, the charging capacity and the discharging capacity retention rate were both improved in Example 2-22 to Example 2-23. In Example 2-24 where each of the concentration of 2,4-difluoroanisole and vinylene carbonate was 15.2 percent by ~~volume~~ weight, the characteristics were deteriorated. In

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short, it is verified that the discharging capacity and cycle characteristic can both be improved if 2,4-difluoroanisole and vinylene carbonate are contained in the electrolyte. Furthermore, if the concentration of 2,4-fluoroanisole and vinylene carbonate is 15 percent by ~~volume~~ weight and below, the characteristic can be further improved.

Page 63, second paragraph

Moreover, according to the secondary battery of still another aspect of the invention, the ability of charging capacity of the negative electrode material capable of occluding/releasing light metal is 150 mAh/g and more, the thickness of the negative electrode mixture layer is from 10 μ m to 300 μ m, both inclusive, and the negative electrode material contains 50 percent by ~~volume~~ weight and more of a negative electrode active material. Therefore, effects of further improving the cycle characteristic and the boosting charging characteristic can be obtained.

Page 64, second paragraph

Furthermore, according to the secondary battery of still another aspect of the invention, the electrolyte contains a non-aqueous solvent which contains propylene carbonate with the concentration of less than 30 percent by ~~volume~~ weight, and mass fraction of mixing ethylene carbonate with propylene carbonate is set to be 0.5 and more. Therefore, effects of improving the cycle characteristic can be obtained even if, for example, graphite is used as the negative electrode material.